420 Rec'd PCT/PTO 12 OCT 1999

FORM PTO-1390 (Modified) (REV 10-95) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
4359-5 PCT	
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	
09/402751	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DK98/00154	April 14, 1998	April 14, 1997

TITLE OF INVENTION

AN APPARATUS AND A METHOD FOR ILLUMINATING A LIGHT-SENSITIVE MEDIUM

APPLICANT(S) FOR DO/EO/US

Henning Henningsen

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 18 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
    A **SECOND** or **SUBSEQUENT** preliminary amendment.
16. ☐ A substitute specification.
17. ☐ A change of power of attorney and/or address letter.
18. ☒ Certificate of Mailing by Express Mail
19. ☒ Other items or information:

Small entity statement

Attorney Docket No.: 4359-5 PCT
Express Mail Label No.: EJ619624755US

420 Rec'd PCT/PTO 12 OCT 1999

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/402751	PCT/DK98/00154	4359-5 PCT

20. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Search Report has been prepared by the EPO or JPO	**$930.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482)	**$720.00**
☐	No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))	**$790.00**
☒	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO	**$1,070.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)	**$98.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =	**$970.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	22 - 20 =	2	x $18.00	**$36.00**	
Independent claims	2 - 3 =	0	x $78.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
	TOTAL OF ABOVE CALCULATIONS =			**$1,006.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)**.			☒	**$503.00**	
	SUBTOTAL =			**$503.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).			+	**$0.00**	
	TOTAL NATIONAL FEE =			**$503.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☒	**$40.00**	
	TOTAL FEES ENCLOSED =			**$543.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$543.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **11-0215** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Gerald Levy, Esq.
Reg. No. 24, 419
KANE, DALSIMER, SULLIVAN & LEVY, LLP
711 Third Avenue
New York, New York 10017

(212)687-6000

SIGNATURE

Gerald Levy
NAME

24,419
REGISTRATION NUMBER

October 12, 1999
DATE

Attorney Docket No.: 4359-5 PCT
Express Mail Label No.: EJ619624755US

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (c)) - SMALL BUSINESS CONCERN	Docket No. 4359-5 PCT

Serial No.	Filing Date	Patent No.	Issue Date
N/A	Herewith	N/A	N/A

Applicant/ Patentee: **Henning Henningsen**

Invention: **AN APPARATUS AND A METHOD FOR ILLUMINATING A LIGHT-SENSITIVE MEDIUM**

I hereby declare that I am:

- ☐ the owner of the small business concern identified below:
- ☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: **DICON A/S**

ADDRESS OF CONCERN: **Sonderskovvej 5, DK-8520 Lystrup, Denmark**

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above identified invention described in:

- ☒ the specification filed herewith with title as listed above.
- ☐ the application identified above.
- ☐ the patent identified above.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed on the next page and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 CFR 1.9(c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Attorney Docket No.: 4359-5 PCT
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Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

☒ no such person, concern or organization exists.
☐ each such person, concern or organization is listed below.

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: Henning Henningsen Name
TITLE OF PERSON SIGNING OTHER THAN OWNER: R&D Manager Title
ADDRESS OF PERSON SIGNING: **DICON A/S**
Sonderskovvej 5, DK-8520 Lystrup, Denmark

SIGNATURE: _____ DATE: 1-10-1995 Date

4359-5 PCT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Henning Henningsen
Serial No.:	Not yet assigned
Filed:	Herewith
For:	**AN APPARATUS AND A METHOD FOR ILLUMINATING A LIGHT-SENSITIVE MEDIUM**
International Appln. No.:	PCT/DK98/00154
International Filing Date:	April 14, 1998
Priority Date:	April 14, 1997

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New York, New York 10017
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PRELIMINARY AMENDMENT

Box PCT
Assistant Commissioner for Patents
Washington, D.C. 20231

Attention: EO/US

S I R:

Prior to any action and for purposes of determining the filing fee, kindly amend the above captioned application as follows:

Attorney Docket No.: 4359-5 PCT
Express Mail Label No.: EJ619624755US

In the claims:

Claim 3, line 1, delete "or 2".

Claim 4, line 1, change "claims 1 - 3" to --claim 1--.

Claim 5, line 1, change "claims 1 - 4" to --claim 1--.

Claim 6, line 1, change "claims 1 - 5" to --claim 1--.

Claim 7, line 1, change "claims 1 - 6" to --claim 1--.

Claim 8, line 1, change "claims 1 - 7" to --claim 1--.

Claim 10, line 1, delete "or 9".

Claim 11, line 1, change "claims 8 - 10" to --claim 8--.

Claim 12, line 1, change "claims 1 - 11" to --claim 1--.

Claim 13, line 1, change "claims 1 - 12" to --claim 1--.

Claim 14, line 1, change "claims 1 - 13" to --claim 1--.

Claim 15, line 1, change "claims 1 - 14" to --claim 1--.

Claim 16, line 1, change "claims 1 - 15" to --claim 1--.

Claim 17, line 1, change "claims 1 - 16" to --claim 1--.

Claim 18, line 1, change "claims 1 - 17" to --claim 1--.

Claim 19, line 1, change "claims 1 - 5 and claims 7 - 17" to --claim 1--.

Claim 22, line 1, delete "or 21".

Remarks

The present amendment is filed with the above captioned application for purposes of conforming the claims to U.S. practice and to reduce the number of claims for purposes of determining the filing fee.

An early action on the merits is now respectfully requested.

Respectfully submitted,

Gerald Levy
Reg. No. 24,419

AN APPARATUS AND A METHOD OF ILLUMINATING A LIGHT-SENSITIVE MEDIUM

Field of the invention

The invention relates to an illumination unit and a method of point illumination of a medium comprising a plurality of light emitters in the form of light guides which are arranged to illuminate at least one illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves.

The art comprises various types of illumination systems of the type where a continuous high power light source, e.g. an Hg or Xe lamp, illuminates a plurality of illumination points on a light-sensitive medium via a given type of light modulators.

However, the technology has not been a great commercial success, because many light valve types have a very low coefficient of utilization, and, accordingly, distribution of light over a large illumination face will typically give greater optical losses and thereby cause the emitted optical power on the illumination point to be reduced considerably. As a result of this circumstance, the available optical energy will frequently tend to be concentrated in one specific small illumination area, rather than trying to distribute it over a large area for an extended period of time because of the limited illumination power and thereby achieve a reduced illumination power over the individual illumination points.

A drawback of this prior art caused by the above-mentioned problems is that it is necessary to place a very large number of light valves in a light valve array on a

very small area, as it is very difficult to distribute sufficient optical power over a large area, and also difficult to achieve a uniform surface illumination.

Computer to plate technology, which is known e.g. from US Patent No. 5 049 901 in which e.g. printing plates are illuminated via DMD light valves, involves the problem that it is not possible to have sufficient optical power distributed over a large area. The patent thus describes how illumination on a scanning line is maintained as best as possible for the longest possible period of time by illuminating the same scanning line with several rows of light valves. Another consequence of the relatively low illumination power may also be that special printing plates having an increased light sensitivity have to be used, which for one thing are expensive in use and for another make greater requirements with respect to storage and use than the conventional printing plates. A further possible consequence of this relatively low achievable optical energy is that the illumination time of the system must be increased considerably. This increase in time consumption, however, is not very expedient as the overall necessary exposure time for a printing plate is increased considerably.

A further drawback of optical distribution over a large area is that the use of e.g. a large number of light sources may give rise to rather pronounced edge problems which occur at the boundary areas between the illumination profiles and the illumination area of the individual light sources. These edge problems have previously been avoided either by illuminating an illumination area with the same light emitter, or alternatively by illuminating each individual illumination point with a separate optical fibre. Systems of the first-mentioned type, which are known from US Patent Specification No. 4 675 702, have

the drawback that the illumination area is restricted physically, thereby calling for a complicated relative mechanical movement between the illumination unit and the substrate.

The last-mentioned type provides a uniform illumination on the illumination face, as the illumination intensity varies between each illumination point so that the variation of the illumination intensity is not visible. A drawback of the last-mentioned type, which is known from US Patent Specification No. 4 899 222, is that the system is extremely complicated, as an optical fibre is required for each illumination point. This means that the light distribution from the light source to the light modulators requires the use of a very large number of optical fibres, and that a very precise adjustment of each individual optical fibre is required with respect to the light source as well as the light modulators. It should be recalled in this connection that each individual optical fibre must be re-adjusted by routine exchange of light source.

The above-mentioned light modulator systems are additionally vitiated by the drawback that the transmission attenuation is very high, whereby high power illumination on the medium to be illuminated is extremely difficult or downright impossible.

Summary of the invention

When, as stated in claim 1, at least two of the light emitters are arranged to illuminate a plurality of light valves each, it is possible to achieve a very high transmitted illumination intensity combined with a very even and uniform surface illumination.

The prior art does not involve a decided, effective specific distribution from more than one light emitter over a large area or subarea of light valves. When light is distributed via several light emitters, each of which illuminates a plurality of light valves, it is also possible to use several light sources in a simple manner, and each said light source may be dedicated to precisely one light guide so that the power achieved has a maximum value.

A further advantage of distributing light by means of light guides is that light may suitably be mixed in couplers or the like to achieve a greater sum of transmitted power in the individual light guides.

A further advantage of the invention is that it gradually becomes possible to achieve increased input powers from e.g. lamps in the UV range, so that the power transmitted to the light valves will be so great that the individual light emitters can emit light having a sufficiently great energy to illuminate several light valves at the same time.

It has also been found in connection with the use of e.g. UV lamps that the introduction of macro illumination areas, i.e. each area illuminated by a single light guide, gives no significant edge effects between each illumination area, just as it has been found that any great variations between the emitted powers from each light guide (as a function of a varying intensity profile from a connected lamp e.g. because of different positioning of the coupling optics for the individual fibres with respect to the lamp) may be compensated by suitable mixing of the light guides, whereby the result of the complete illumination has a uniform visual appearance without significant differences in intensity in the edge areas.

The above-mentioned mixing may e.g. be performed in consideration of the circumstance that adjacent macro illumination areas receive optical power which does not differ significantly from each other, while macro illumination areas oriented relatively remotely from each other may have a somewhat greater difference in intensity, without this causing considerable visual disturbances on the illumination surface.

An additional advantage of the invention may be obtained by filtering the light to or emitted from the individual light guides, so that the illumination intensity is uniform from all the light guides or some of these.

In contrast to the prior art, an apparatus according to the invention may be constructed in a relatively simple manner, while achieving high resolution, high illumination rate, good precision and uniform illumination intensity over a very large illumination area.

The invention is particularly advantageous in connection with light valves which are vitiated by relatively great losses. An example of such light valve types may e.g. be electrooptically based light valves, such as LCD, PDLC, PLZT, FELCD and Kerr cells. Other types of light valves may e.g. be electromechanical reflection-based light modulators of the DMD type.

According to the invention, it is thus possible to sum light over a large surface in a simple manner using relatively few light guides, just as it is possible to orient the light emitters in the illumination system relatively freely as the light emitters consist of light guide ends rather than e.g. a light source with associated optical system, drivers and coolants.

A particularly advantageous embodiment of the invention is achieved for transmissive light valves, as these result in the fewest possible optical losses, which may be quite decisive for the functionality of certain applications.

When, as stated in claim 2, the illumination unit additionally comprises a first lens arrangement, said lens arrangement comprising at least one micro lens arranged with respect to each light valve so that the light emitted by the light emitter or emitters is focused on or in the vicinity of the optical axis of the individual light valves, a high utilization of the light power emitted from the light emitter is achieved.

When, as stated in claim 3, the illumination arrangement additionally comprises a second micro lens arrangement arranged between the light valves and the illumination face, so that light transmitted through the light channel of the individual light valve is focused suitably on the illumination surface, it is ensured that the light from each channel falls on small points with high intensity on the illumination surface.

When, as stated in claim 4, the optical light guide or guides are formed by optical fibres, a small loss of light intensity as well as great constructional flexibility in the spatial positioning of the individual elements is achieved.

The use of multimode fibres opens up the possibility of illuminating the illumination surface with more broad-spectral light.

When, as stated in claim 5, at least one of the light sources is formed by a short arc gap lamp, a high emitted light power is achieved from an area of limited physical extent (high radiation intensity).

When, as stated in claim 6, the light source comprises a short arc gap lamp having light receiving optical light guides or fibres which are arranged within an angle of +/- 75° with respect to the equator axis (E) of the lamp on a ball face around the lamp, and which are optically connected to and conduct light to the light emitters, it is ensured that the predominant part of the light emitted from the light source is gathered in the light guides, whereby the coefficient of utilization is very high.

When, as stated in claim 7, at least one of the light sources is formed by a laser source, it is possible to distribute the light sources so that e.g. a row of laser sources can supply the total number of light valves.

When, as stated in claim 8, the illumination unit comprises a plurality of light emitters in the form of light guides, each of which is optically connected to a light source arranged to illuminate a plurality of light valves arranged in a given face shape, at least one collimation lens being arranged between the light emitter and the face shape so that collimated light is conducted to a first micro lens arrangement associated with the plurality of light valves, a homogeneous illumination of a plurality of the light valves from each light emitter is achieved.

When, as stated in claim 9, the face shape of the light valves forms a hexagon, a good approximation to a circle and thereby a high utilization of the light energy from a light emitter of circular geometry are achieved. Another

advantage is that hexagonal illumination faces are extremely advantageous to use in connection with scanning movements of a plurality of illumination units built together. Thus, hexagons may suitably be shaped and positioned mutually offset in and transversely to the scanning direction.

When, as stated in claim 10, the individual light valves are arranged in rows in the transverse direction of the face shape with the light valves at a given mutual distance, said rows being mutually offset in the transverse direction, it is possible to distribute the light linearly over a great width.

When, as stated in claim 11, the rows are arranged such that the projection of all the individual light valves in the transverse direction in the face shape results in a plurality of illumination points at a mutual distance in the transverse direction, it is ensured that light may fall on points with a considerably higher resolution than corresponding to the distance between the individual light valves because of their physical extent if these were positioned in a single row in the transverse direction.

When, as stated in claim 12, the face shape or shapes of the light valves are arranged on one or more illumination heads, each illumination head and the illumination face being adapted to perform a relative movement across an illumination area, said device being also provided with a control unit for controlling the light valves in dependence on the relative movement between the illumination head and the illumination face, an advantageous embodiment of the invention is achieved.

When, as stated in claim 13, the illumination head or heads are arranged as a rod whose relative movement with the illumination face is a simple progressing movement in the transverse direction of the rod, it is ensured that illuminated points may be generated in the entire or a considerable part of the width of the illumination face and by virtue of the scanning movement on the entire or a considerable part of the illumination face.

When, as stated in claim 14, the illumination unit between the light valve arrangement and the illumination face additionally comprises optical means for spreading the light beams emitted by the light channels across the illustration face, exposure is ensured over an area which is physically larger than the area covered by the light channels, thereby e.g. allowing compensation for non-active edge areas around a light valve arrangement.

When, as stated in claim 15, the light valves of the illumination unit are formed by electrooptically based light valves (spatial light modulators), such as LCD, PDLC, PLZT, FELCD or Kerr cells, a great design flexibility is achieved with respect to selection of light modulator principle in the individual application, including also that standardized components can reduce the production price.

When, as stated in claim 16, the light valves of the illumination unit are formed by reflection based electromechanical light valves, such as DMD chips, a solution with high spatial resolution is achieved.

When, as stated in claim 17, the light valves of the illumination unit are formed by transmission based electromechanical light valves, a solution with a very low dimming of light through the modulator is achieved.

When, as stated in claim 18, the light guides of the illumination device are so arranged with respect to the light valve arrangement that the optical energy fed to each subset of light valves does not differ significantly from each other when the subsets of light valves illuminate adjacent areas or areas close to each other on the illumination face, it is ensured that the permissible variation in light intensity between all light emitters may be increased without this becoming visible.

When, as stated in claim 19, the light receiving ends of the light guides are gathered in at least one bundle which directly or indirectly receives light from a reflector or a reflector system optically connected to at least one lamp, a better possibility of centrally controlling both amount and variation of the light injected into the light guide is achieved.

Drawings

The invention will be explained more fully below with reference to the drawings, in which

fig. 1 shows a basic sketch of an embodiment of the invention,

fig. 2 shows a more detailed sketch of a subarea shown in fig. 1,

fig. 3 shows an additional example of an embodiment of a subarea according to the invention,

fig. 4 shows an embodiment in which the subareas shown in fig. 3 are arranged on e.g. a scanning rod,

fig. 5 shows an embodiment with a plurality of illumination modules arranged on a scanning rod,

fig. 6 shows a cross-section of an illumination system according to the invention with LCD light valves.

Example

Fig. 1 shows a basic sketch of an embodiment of the invention.

Thus, an illumination system comprises a lamp 1 which is optically connected with a plurality of light receiving ends of light guides, such as optical fibres 3 which are gathered in a fixture 2.

At the opposite end of the optical fibres 3, the optical fibres 3 are optically connected to a plurality of subareas or zones 4, each of which comprises a plurality of light valves (not shown).

The light guides 3 thus conduct light to the subareas 4 where the fed light is modulated on an illumination face 5.

The light valve arrangement shown in fig. 1 may e.g. be arranged for flash exposure, i.e. all illumination points on the complete illumination face may be illuminated at the same time.

The light valve arrangement shown in fig. 1 may moreover be constructed on the basis of an array having a very large number of light valves, the total area being divided into a plurality of subareas which each are illuminated by a light guide 3.

Fig. 2 is a close-up of one of the subareas 4 shown in fig. 1.

Each subarea comprises a plurality of light valves 6 which may individually be controlled electrically by a control unit (not shown) connected to it. The light valve arrangement may e.g. be formed by an LCD display with a given desired resolution.

The entire subarea of light valves 4 is illuminated by one light guide 3 so arranged that a light beam 10, emitted from the light guide 3, can supply optical energy to all the light valves 6 in the subarea.

It should be noted that the light beam will frequently be supplied through collimation optics so that the light beam supplied to the light valve arrangement is plane and uniform in terms of energy.

Fig. 3 shows a further example of an embodiment of a subarea according to the invention.

With respect to the subarea shown in fig. 2, it is noted initially that there are fewer light valves in each subarea.

The shown subarea 4 thus comprises a plurality of light valves 6 with light valve apertures 6'.

It will be seen that the selected light valve arrangement has had the light valves at the corner diaphragmed so that the shape of the subarea approximates a circumcircle. It will be appreciated that, for explanatory reasons, the selected example has a reduced number of light valves, and a larger number of light valves can therefore

be approximated more easily to a desired face-shaped or matrix structure.

An advantage of an approximately circular face shape is that it is relatively easy to distribute light over the light valve arrangement from a light guide, as a light guide will typically have a circular cross-section.

It will be seen from fig. 4 how three subareas 14 of light valves 6, 6' are arranged as cooperating illumination units for performing a scanning movement and illumination perpendicularly to a scanning line 9. In the shown projection of light on the scanning line 9 the complete light valve arrangement moves perpendicularly to the scanning line 9 and performs illumination in the normal direction of the units. As will appear, the light aperture 6' of the individual light valves 6 gives a contribution on the scanning line with equidistant illumination points in the form of an illumination point 6".

The shown arrangement may e.g. be constructed on a movable scanning rod (not shown) with associated control electronics (not shown).

The shown structure may be built more economically than e.g. arrangements for flash exposure, just as it will be possible to increase the resolution in a simple manner. This will be discussed in greater detail below.

As will appear from the example, the subareas used have an inclination with respect to their projection on the scanning line 9. The shown arrangement thus gives an increase in the resolution which corresponds to the number of rows in the light valve arrangement. The angle with respect to the scanning line 9 of each illumination mod-

ule is adapted so as to create an equidistant spacing between the points 6" projected down on the line 9.

As an alternative to the arrangement described above, the system may be arranged with redundancy by allowing several light valves to illuminate the same illumination point. This may e.g. be a distinct advantage in connection with light valve types in which a certain functional uncertainty occurs, i.e. non-functioning mirrors or valves. Such a redundancy may e.g. be achieved by rotating a larger array of light valves so that selected light valves, when scanning past an illumination face or scanning line, illuminate the same point.

It should be recalled in this connection that generally a very small or no percentage of error must be accepted for the light valves involved if these are used as "stand alone", for which reason redundancy will allow some uncertainty on the individual illumination modules. This in turn reduces the unit price of the light valve units involved.

An advantage of the shown example is that standard light valve structures may be used with an ordinary matrix position of the light valves, such as e.g. light valves of the LCD type, rather than having to produce subareas with a particular and specific layout of light valves.

However, it will be appreciated that the individual subareas or the complete light valve arrangement, if so desired, may be produced in one total formation of light valves in a given specific layout.

It should moreover be noted that a further advantage of the invention is particularly pronounced when using a scanning light valve arrangement, as the light valve ar-

rangement in its entirety normally requires a very elongated light supply line (corresponding to the length of the desired scanning line). Such an elongated light profile may be extremely difficult to achieve without using light guides, as the optics used may be extremely complicated and bulky.

Fig. 5 shows a section of a further embodiment of the invention, the light valve layout being produced directly in this case with row displacement between the individual light valve rows.

The light valve arrangement shown is adapted to scan across an illumination face in the scanning direction SD.

The light valve arrangement is arranged with a plurality of light valves 6 positioned in rows, e.g. LCD light valves. Each light valve has an illumination aperture 6' which is electrically activatable and deactivatable. When the light valve 6 is open, it will thus illuminate an illumination place arranged below the light valve. This illumination place will be a scanning line 9 in the shown case.

As shown in the drawing, the light valve arrangement projections 30 together form an illumination line SL on which the illumination points have a mutual given centre distance. The projections illustrate how the individual points are generated when the individual light valves pass the scanning line SL in the direction SD.

It will be appreciated that the illumination arrangement is controlled by control means (not shown) which ensure that the individual light valves open with a suitable mutual time delay so that an ordinary scanning line is reformed on the scanning line SL, even though the passage

of the light valve rows across the scanning line is temporally staggered.

In the shown case the illumination resolution achieved corresponds to the mutual shifting between each adjacent row. However, it will be appreciated that the layout shown just represents one of many conceivable light valve layouts within the scope of the invention.

An advantage of the shown embodiment is that the light valve arrangement may be produced directly and specifically for the task for which the device might be intended, thereby facilitating the mutual positioning of cooperating illumination modules.

Fig. 6 shows a cross-section of an embodiment according to the invention.

Fig. 6 thus shows an illumination system comprising a bundle of light guides 20 whose light receiving ends may be arranged to receive light from one or more light sources (not shown).

The light guide bundle 20, which may e.g. consist of optical fibres, forms a plurality of light emitters arranged to illuminate collimation optics 23 so that each light emitter in the fibre bundle is collimated individually to collimated light beams 28.

The collimated light beams 28 are subsequently conducted to an LCD modulation board 24 consisting of one LCD array, in which the individual LCD light valves are adapted to modulate the incident light in dependence on electrical control signals to outgoing macro light beams 29 of micro light beams. Each macro light beam 29 consists of a plurality of individually modulated micro light beams.

The micro light beams are not shown in fig. 6 owing to the resolution achievable in the figure.

As an alternative embodiment of the invention the LCD board might be constructed as a plurality of LCD arrays which each are illuminated by precisely one light emitter or a subset of light emitters from the fibre bundle 20.

Subsequently, the macro light beams 29 are conducted to a plurality of macro objective systems which each may consist of e.g. associated macro lenses 25, 26. The macro objective systems subsequently conduct the macro light beams to an illumination point in the form of e.g. a printing plate.

The shown embodiment can perform stationary flash exposures of stationary illumination faces depending on the structure and dimensioning of the optical system and the LCD board.

Alternatively, the shown embodiment may be arranged for relative movement between the illumination face and the illumination system in the form of e.g. a scanning, as shown in fig. 4 and fig. 5.

PATENT CLAIMS

1. An illumination unit for point illumination of a medium comprising a plurality of light emitters (3) in the form of light guides arranged to illuminate an illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves, c h a r a c t e r i z e d in that at least two of the light emitters (3) are arranged to illuminate a plurality of light valves (6) each.

2. An illumination unit according to claim 1, c h a r a c t e r i z e d in that it additionally comprises a first lens arrangement, said lens arrangement comprising at least one micro lens arranged with respect to each light valve so that the light emitted by the light emitter or emitters is focused on or in the vicinity of the optical axis of the individual light valves.

3. An illumination unit according to claim 1 or 2, c h a r a c t e r i z e d in that it additionally comprises a second micro lens arrangement arranged between the light valves and the illumination face, so that light transmitted through the light channel of the individual light valve is suitably focused on the illumination face (5).

4. An illumination unit according to claims 1-3, c h a r a c t e r i z e d in that the optical light guide or guides (3) are formed by optical fibres, preferably multimode fibres.

5. An illumination unit according to claims 1-4, c h a r a c t e r i z e d in that at least one of the light sources (1) is formed by a short arc gap lamp.

6. An illumination unit according to claims 1-5, c h a r a c t e r i z e d in that the light source comprises a short arc gap lamp (1) having light receiving optical light guides or fibres (3) which are arranged within an angle of +/- 75° with respect to the equator axis of the lamp on a ball face around the lamp, and which are optically connected to and conduct light to the light emitters.

7. An illumination unit according to claims 1-6, c h a r a c t e r i z e d in that at least one of the light sources is formed by a laser source.

8. An illumination unit according to claims 1-7, c h a r a c t e r i z e d in that it comprises a plurality of light emitters (3) in the form of light guides, each of which is optically connected to a light source (1) arranged to illuminate a plurality of light valves (6) arranged in a given face shape, at least one collimation lens being arranged between the light emitter and the face shape so that collimated light is conducted to a first micro lens arrangement associated with the plurality of light valves.

9. An illumination unit according to claim 8, c h a r a c t e r i z e d in that the face shape of the light valves forms one or more hexagons.

10. An illumination unit according to claim 8 or 9, c h a r a c t e r i z e d in that the individual light valves are arranged in rows in the transverse direction (9) of the face shape with the light valves at a given mutual distance, and that the rows are mutually offset in the transverse direction.

11. An illumination unit according to claims 8-10,

c h a r a c t e r i z e d in that the rows are arranged such that the projection of all the individual light valves in the transverse direction (9) in the face shape results in a plurality of illumination points at a mutual distance in the transverse direction (9).

12. An illumination unit according to claims 1-11, c h a r a c t e r i z e d in that the face shape or shapes of the light valves are arranged on one or more illumination heads, each illumination head and the illumination face being adapted to perform a relative movement across an illumination area, said device being also provided with a control unit for controlling the light valves in dependence on the relative movement between the illumination head and the illumination face.

13. An illumination unit according to claims 1-12, c h a r a c t e r i z e d in that the illumination head or heads constitute a rod whose relative movement with the illumination face is a single progressing movement in the transverse direction of the rod.

14. An illumination unit according to claims 1-13, c h a r a c t e r i z e d in that the illumination unit between the light valve arrangement and the illumination face additionally comprises optical means for spreading the light beams emitted by the light channels across the illumination face.

15. An illumination unit according to claims 1-14, c h a r a c t e r i z e d in that the light valves of the illumination unit are formed by electrooptically based light valves (spatial light modulators), such as LCD, PDLC, PLZT, FELCD or Kerr cells.

16. An illumination unit according to claims 1-15,

c h a r a c t e r i z e d in that the light valves of the illumination unit are formed by reflection based electromechanical light valves, such as DMD.

17. An illumination unit according to claims 1-16, c h a r a c t e r i z e d in that the light valves of the illumination unit are formed by transmission based electromechanical light valves.

18. An illumination unit according to claims 1-17, c h a r a c t e r i z e d in that the light guides of the illumination unit are so arranged with respect to the light valve arrangement that the optical energy fed to each subset of light valves does not differ significantly from each other when the subsets of light valves illuminate adjacent areas or areas close to each other on the illumination face.

19. An illumination unit according to claims 1-5 and claims 7-17, c h a r a c t e r i z e d in that the light receiving ends of the light guides are gathered in at least one bundle which directly or indirectly receives light from a reflector or a reflector system optically connected to at least one lamp.

20. A method of point illumination of a medium by means of a plurality of light emitters (3) in the form of light guides which are arranged to illuminate an illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves, c h a r a c t e r i z e d in that at least two of the light emitters (3) are arranged to illuminate a plurality of light valves (6) each.

21. A method according to claim 20, c h a r a c t e r -

i z e d in that the light emitted by the light emitter or emitters is focused on or in the vicinity of the optical axis of the individual light valves via a first lens arrangement, said lens arrangement comprising at least one micro-lens arranged with respect to each light valve.

22. A method according to claim 20 or 21, c h a r a c t e r i z e d in that the light transmitted through the light channel of the individual light valve is suitably focused on the illumination face (5) via a second micro lens arrangement arranged between the light valves and the illumination face.

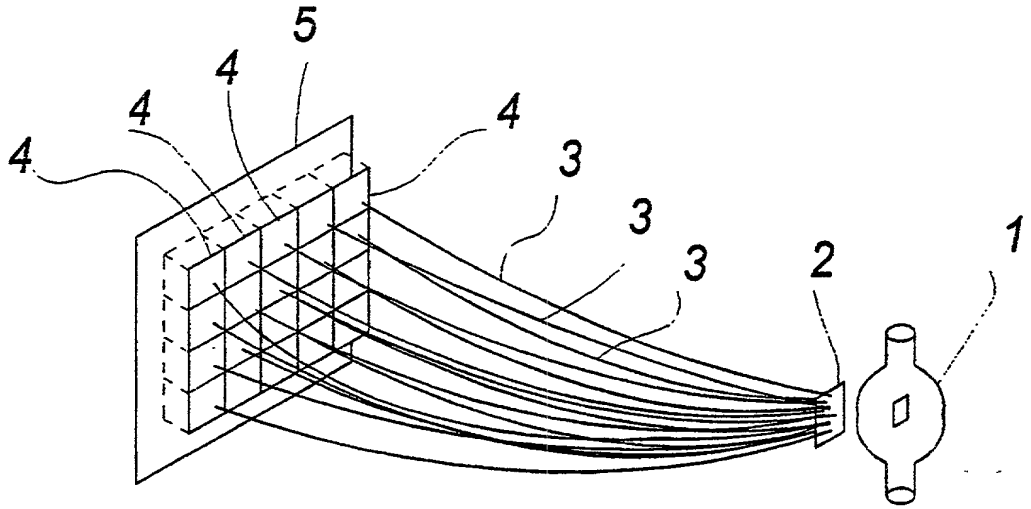

Fig.1

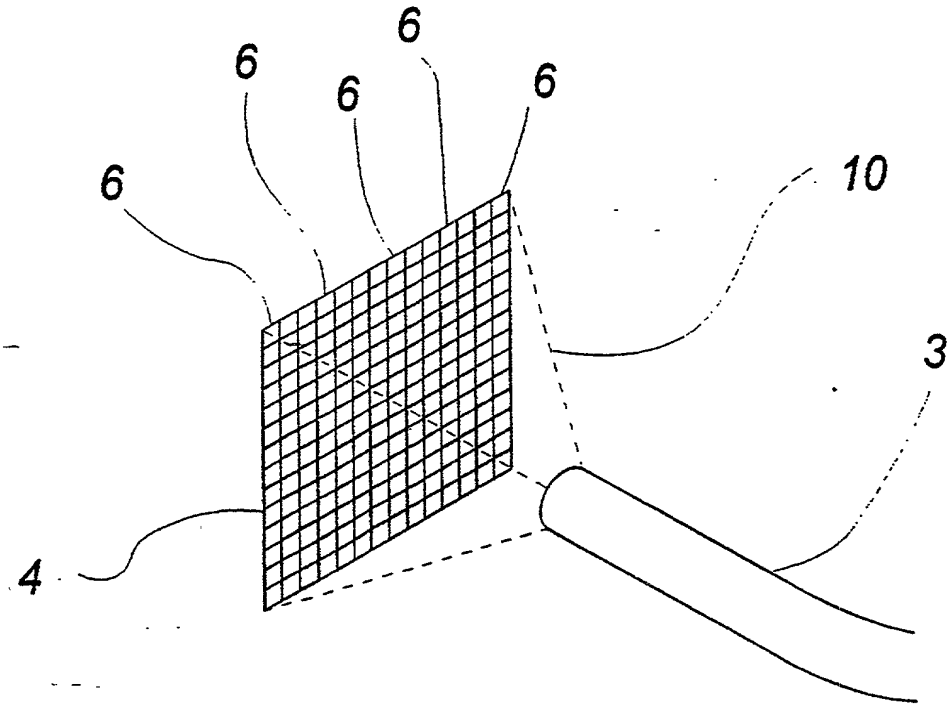

Fig.2

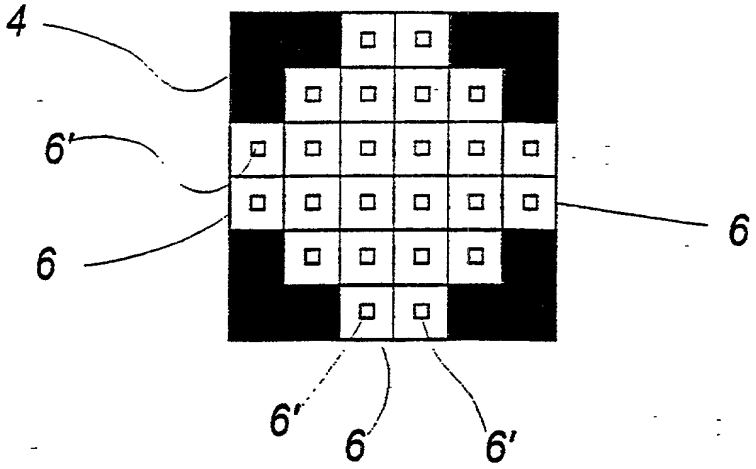

Fig.3

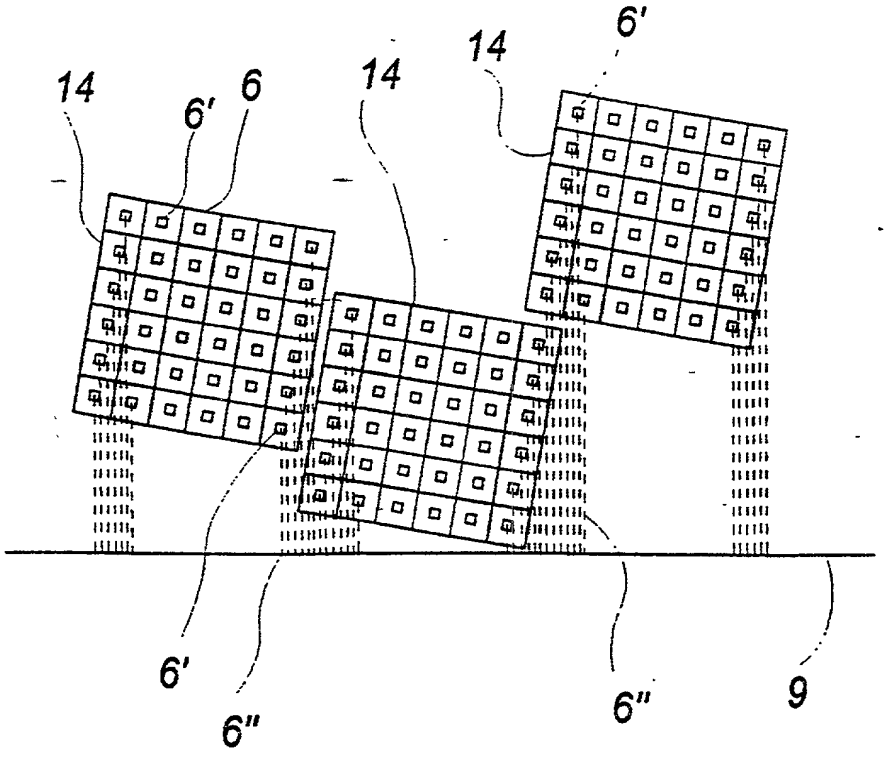

Fig.4

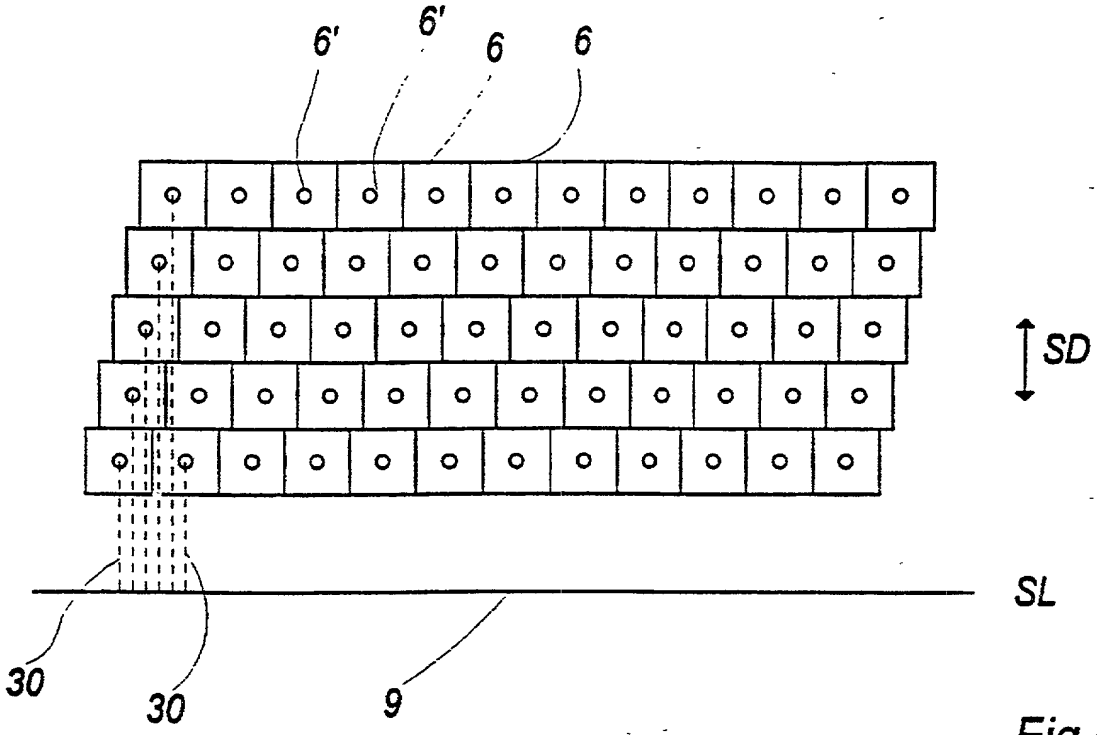

Fig.5

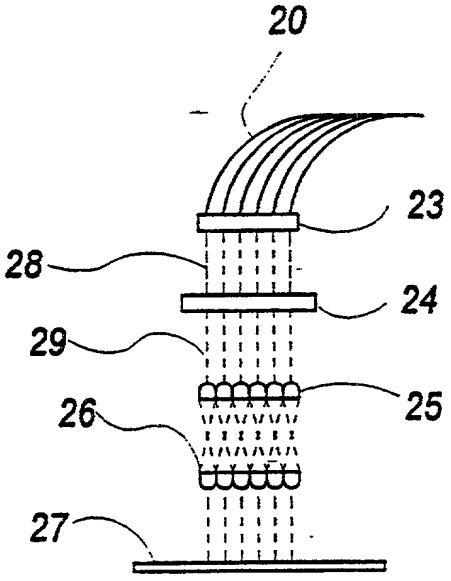

Fig.6

COMBINED DECLARATION AND POWER OF ATTORNEY TO BE FILED WITH U.S. DESIGNATED OFFICE UNDER 35 U.S.C. 371 (c)(4)

As a below named inventor(s), I (We) hereby declare that:
My (Our) residence, post office address and citizenship are as stated below next to my (our) name(s). I (We) believe I (we) am (are) the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled
AN APPARATUS AND A METHOD FOR ILLUMINATING A LIGHT-SENSITIVE MEDIUM, the specification of which is attached hereto and:

X was filed on **April 14, 1998** as PCT International
Application Number **PCT/DK98/00154**
and was amended on _____ (if applicable).

I (We) hereby state that I (we) have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

☐ I (We) acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

☐ I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)			
NUMBER	COUNTRY	DATE FILED	PRIORITY CLAIMED
415/97	Denmark	April 14, 1997	YES
63/98	Denmark	January 16, 1998	YES
			YES NO

I (We) hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

APPLICATION NO.	FILING DATE	STATUS PATENTED,PENDING, ABANDONED

I (We) hereby declare that all statements made herein of my (our) own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I (We) hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Joseph C. Sullivan, Registration No. 18,720; Gerald Levy, Registration No. 24,419; Ronald R. Santucci, Registration No. 28,988; Ronald E. Brown, Registration No. 32,200; John Gulbin, Registration No. 33,180; Richard J. Danyko, Registration No. 33,672; Monami D. Roy, Registration No. 40,892; Tod M. Melgar, Registration No. 41,190; James E. Marina, Registration No. 41,969 and Clifford A. Ulrich, Registration No. 42,194. ***I (We) further authorize my (our) attorney to insert the proper serial number and filing date awarded to my (our) application on this document, above my (our) signature(s).**

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